

REMARKS

Claims 1-4, 6-18, 20-31, 34-39, 41-44, 50, 52-95, and 97 are pending. Claims 1, 15, 16, 29-31, 50, 54, 67, 70, 92, and 95 are amended. Claims 5, 19, 32, 33, 40, 45-49, 51, 83, and 96 are cancelled, without prejudice to the underlying subject matter. Please consider the following remarks.

Claims 30 and 31 stand objected to for informalities. Claims 30 and 31 are amended to further clarify the recited subject matter. Applicants respectfully request that the objection be withdrawn.

Claims 16, 29, and 54 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,204,192 ("Zhao et al.") in view of U.S. Patent 5,970,376 ("Chen"). Applicants respectfully traverse this rejection.

Claim 16, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites "contacting said opening with a plasma consisting of oxygen to remove a portion of said etch residue, stopping said oxygen plasma contacting before said polymer etch residue is completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma, said second plasma consisting of a hydrogen containing gas, and treating said opening with at least one of ammonium chloride or phosphoric acid to remove a nitride deposit formed by said second plasma." This is not taught or suggested by Zhao et al. in view of Chen.

Neither Zhao et al. nor Chen teach or suggest a method utilizing "contacting said opening with a plasma consisting of oxygen to remove a portion of said etch residue, stopping said oxygen plasma contacting before said polymer etch residue is

completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma, said second plasma consisting of a hydrogen containing gas, and treating said opening with at least one of ammonium chloride or phosphoric acid to remove a nitride deposit formed by said second plasma.” Use of two plasmas, a first containing oxygen and a second containing hydrogen, followed by a treatment of ammonium chloride or phosphoric acid to remove a nitride deposit formed by the second plasma is not taught or suggested anywhere in Zhao et al. or Chen. Neither of these references suggests that a second plasma used to remove etch residue can form a nitride and neither of these references suggests use of ammonia chloride or phosphoric acid after plasma treatment.

Since the references, whether or not combined, fail to teach or suggest each limitation of the claim, claim 16 is patentable thereover. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claim 16 be withdrawn.

Claim 29, as amended, defines a method of forming a contact opening in a semiconductor device and recites, in part, “b) contacting said opening with an oxygen plasma to remove a portion of said etch residue” and “c) removing any remaining etch residue from said etched opening by contacting said opening with a plasma consisting of a hydrogen containing gas in the absence of added oxygen” and “d) treating said contact opening with one of ammonium chloride and phosphoric acid after step (c).” Such a method is not taught or suggested by Zhao et al. in view of Chen.

Among other recited features of claim 29, neither Zhao et al. nor Chen teaches or suggests following a two-plasma treatment of a contact opening by treating the contact opening with one of ammonium chloride and phosphoric acid. Therefore,

for at least this reason, claim 29 is patentable over these references. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claim 29 be withdrawn.

Claim 54, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, “first contacting said opening with a first plasma to remove a portion of said polymer etch residue; stopping said first contacting; and subsequently contacting said opening with a second plasma to remove the remainder of said polymer etch residue, said first plasma being generated from a gas other than a hydrogen-containing gas and said second plasma being generated from a gas consisting of hydrogen gas, wherein said first and said subsequent contacting with said first and second plasmas are configured to prevent the formation of silicon oxide in said opening.” Such a method is not taught or suggested by the combination of Zhao et al. and Chen.

Since, among other features of the claimed method, neither Zhao et al. nor Chen teaches or suggests that first and said subsequent contacting with first and second plasmas can be configured to prevent the formation of silicon oxide in an opening, claim 54 is patentable over these references. For example, if the “ashing” process of Zhao et al. is utilized as part of a method as claimed, silicon oxide formation is not prevented, but could actually be encouraged; ashing is an oxidizing process (Zhao et al. at col. 1, l. 55). This is contrary to the claimed method. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claim 54 be withdrawn.

Claims 1-4, 6-18, 20-31, 34-39, 41-44, and 54-91 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zhao et al. in view of U.S. Patent 6,277,733 (“Smith”). Applicants respectfully traverse this rejection.

Claim 1, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, "contacting said opening with a first plasma to remove a portion of said polymer etch residue; stopping said contacting with said first plasma; contacting said opening with a second plasma to remove the polymer etch residue not removed by said first plasma, said second plasma generated from a gas consisting of ammonia and said first plasma being generated from a different gas, said second plasma forming a nitride deposit; and removing any nitride deposits formed by said second plasma in said opening." This method is not taught or suggested by Zhao et al. in view of Smith.

Neither Zhao et al. nor Smith teaches or suggests a method where a second plasma is generated from a gas consisting of ammonia and a first plasma is generated from a different gas, where the second plasma forms a nitride deposit and is followed by removing any nitride deposits formed by the second plasma. For at least this reason, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of independent claim 1 and dependent claims 2-4 and 6-15 be withdrawn.

Claims 16, 29, and 54 are discussed above as being patentable over Zhao et al. individually. As explained above, Zhao et al. does not teach or suggest use of ammonium chloride or phosphoric acid to remove nitride deposits after plasma removal of etch residue; and does not teach or suggest configuring first and second plasmas to remove etch residue and also prevent formation of silicon oxide. Smith cannot supplement the Zhao et al. disclosure to suggest or provide these teachings. Therefore, as is the case of the combination of Zhao et al. and Chen, claims 16, 29, and 54 are likewise patentable over Zhao et al. in view of Smith, too. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of independent claims 16, 29, and 54 and dependent claims 17, 18, 20-31, 34-39, 41-44, and 54-69 be withdrawn.

Claim 70, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, "removing said polymer etch residue by contacting it with a first plasma and a second plasma, said first plasma being used to remove only a portion of said residue, said second plasma being used to remove the remainder of said polymer etch residue, said first plasma generated from a gas not containing hydrogen and said second plasma generated from a gas consisting of methane gas, wherein said removal of said polymer etch residue produces no silicon rich oxide in said opening." Such a method is not taught or suggested by Zhao et al. and Smith.

Zhao et al. and Smith fail to teach or suggest, expressly or inherently, use of two etch residue removing plasmas. Further, neither Zhao et al. nor Smith teaches or suggests that removal of the polymer etch residue by the method produces no silicon rich oxide in the opening. If the "ashing" process of Zhao et al. is utilized as part of a method as claimed, silicon rich oxide formation is not prevented, but could actually be encouraged. This is contrary to the claimed method. Therefore, for at least these reasons, independent claim 70 and dependent claims 71-91 are patentable over these references. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 70-91 be withdrawn.

Claims 50, 52, 53, 92-95, and 97 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zhao et al. in view of Smith, further in view of U.S. Patent 6,284,664 ("Kawai"), and further in view of U.S. Patent 6,291,890 ("Hamada"). Applicant respectfully traverses this rejection.

Claim 50, as amended, defines a method of forming an integrated circuit structure and recites, in part, "removing polymer residue from said contact opening by

first contacting said opening with a first plasma, stopping said first contacting, and subsequently contacting said opening with a second plasma, said first plasma consisting of a gas other than ammonia gas and said second plasma consisting of ammonia gas, said first and second plasma treatments being configured to prevent the formation of silicon oxide on a bottom of said contact opening; treating said bottom of said contact opening to remove any nitride formed by said second plasma.” Such a method is not taught or suggested by Zhao et al. in view of Smith and in view of Kawai and in view of Hamada.

None of Zhao et al., Smith, Kawai, and Hamada teaches or suggests a two plasma process for removal of etch residue where no silicon rich oxide is formed during said removal. For example, if the “ashing” process of Zhao et al. is utilized as part of a method as claimed, silicon oxide formation is not prevented, but could actually be encouraged. This is contrary to the claimed method. Since these references cannot be combined so as to disclose, expressly or inherently, all the features of the claimed method, they would not have rendered the claimed subject matter unpatentable. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of independent claim 50 and dependent claims 52 and 53 be withdrawn.

Claim 92, as amended, defines a method of forming an integrated circuit structure and recites, in part, “removing polymer residue from said contact opening by first contacting said opening with a first plasma, stopping said first contacting, and second contacting said opening with a second plasma, said first plasma comprising a gas not containing hydrogen and said second plasma consisting of hydrogen gas and said first and second plasmas being configured to not produce silicon oxide during said first and second contacting, wherein said removing polymer etch residue providing an oxide free bottom of said contact opening and does not oxidize sidewalls or said bottom

of said opening.” Such a method is not taught or suggested by Zhao et al. combined with Smith combined with Kawai and combine with Hamada.

Among other recited features in this claim, none of the cited references teaches or suggests first and second plasma treatments configured so as not to produce silicon oxide during plasma treatments. For example, if the “ashing” process of Zhao et al. is utilized as part of a method as claimed, silicon oxide formation is not prevented, but could actually be encouraged, as would oxidation of the opening sidewalls and bottom, since ashing is an oxidizing process. This is contrary to the claimed method. Additionally, none of the cited references teaches or suggests that the removal of polymer etch residue using two plasma treatments does not oxidize sidewalls or a bottom of the treated opening. For at least these reasons, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 92-94 be withdrawn.

Claim 95 defines a method of forming an integrated circuit structure and recites, in part, “removing polymer residue from said contact opening by first contacting said opening with an oxygen plasma, stopping said first contacting, and second contacting said opening with a methane-comprising plasma, said removing further preventing the formation of silicon rich oxide during said first and second contactings.” Such a method is not taught or suggested by the combination of Zhao et al., Smith, Kawai, and Hamada.

As has been discussed above in relation to other claims, none of the cited references teaches or suggests dual plasma treatments to remove polymer etch that further prevents the formation of silicon rich oxide during the plasma treatments. For example, if the “ashing” process of Zhao et al. is utilized as part of a method as claimed, silicon oxide formation is not prevented, but could actually be encouraged. This is

contrary to the claimed method. For at least this reasoning, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 95 and 97 be withdrawn.

In view of the above amendment, Applicants believe the pending application is in condition for allowance. Applicants respectfully request that a Notice of Allowance be immediately mailed.

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Respectfully submitted,

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